Background

Oil and natural gas are the lifeblood of the U.S. economy. Together they account for more than 60 percent of the energy consumed in the United States, and oil accounts for 97 percent of transportation fuel. Although the United States is the third-largest oil producer in the world, we import about 60 percent of our oil needs, while two-thirds of all the oil discovered in the country remains in the ground.

The U.S. oil and gas industry has changed dramatically in recent years. Major producers have moved into the international market, leaving the remaining domestic resources for independents to produce. There are roughly 7,000 independents, 90 percent with less than 20 workers. They produce 66 percent of the natural gas and 40 percent of the oil in the United States. Seventy-five percent of America's oil wells are marginal wells, and they account for 20 percent of the Nation's oil production. Every year about 15,000 marginal oil wells are abandoned in the United States.

Halting this loss of resources in the world's most mature oil sector requires a rededication to supporting a level of research that can restore America to its vanguard role in oilfield technology.

Federal funding for oil and gas research generally has tracked industry consolidation. Since the 1973 oil embargo, the U.S. oil and gas industry has suffered two major collapses, followed by periods of extensive consolidation marked by mergers, acquisitions, and drastic spending cuts. Industry R&D spending was among the first victims of such consolidation.

Despite a consensus outlook for elevated oil prices, the industry now faces a new period of consolidation in the coming decade. As more and more of the world's productive capacity is concentrated in the hands of ever-fewer governments not amenable to outside investment, majors and independents alike will find their portfolio of E&P opportunities dwindling—and thus their reserves and production shrinking. Faced with investor concerns over the prospect of self-liquidation as production is replaced at inadequate levels, U.S. companies will be forced into another round of mergers and acquisitions. Thus private oil and gas R&D will shrink further in the United States, even as other governments continue to step up their funding for oil and gas R&D in response to a future climate of oil supply tightness.

Signs of this looming "technology crisis" already have emerged amid waning domestic production—driven by environmental roadblocks and availability of relatively inexpensive oil from abroad—and mergers of multinational corporations. Government laboratories have closed, corporate labs have been downsized, and most innovative research on advanced petroleum production has been drastically cut or totally eliminated. Fortunately, a few academic laboratories, sponsored by the U.S. Department of Energy, have managed to sustain critical research and training of students in strategic areas of advanced recovery. However, significant advances beyond state-of-the-art technologies and application of novel concepts will require concerted endeavor by government, industry, and academia in order to realize DOE's challenging goal of environmentally safe, economically viable domestic petroleum production at a strategically acceptable level.

DOE's oil and gas research programs today continue an emphasis on R&D that pushes cutting-edge technologies to commerciality with clear focus on the Federal role.

The Federal role is defined by the market failure associated with the inability of the remaining few major service companies to find adequate economic incentive to meet the needs of the thousands of American independent producers seeking to recover a bypassed resource whose vast potential eludes them with today's technology.

And because DOE is well-positioned between industry and regulators to champion balanced, cost-effective approaches to environmental protection, the oil and gas research programs also focus on working with industry, regulatory agencies, and communities to help ensure that environmental protection approaches make technical, environmental, and economic sense.

From the beginning of the programs, a response to industry's technology needs with a Federal goal of producing the maximum petroleum possible from the nation's reserves has driven all strategic planning. Recovering the Nation's gas and oil is more crucial than ever at a time when most analysts project that higher oil prices may prove permanent, as concern grows over whether tomorrow's global oil supply will be able to meet demand. The Nation's own levels of oil reserves and production continue to decline and refining capacity continues to lag, while its demand for both crude oil and refined products continues to climb. DOE's Energy Information Administration projects that U.S. dependence on oil imports will rise to more than 62 percent in 25 years from about 59 percent today unless this supply-demand imbalance changes.

A major impact of DOE's oil and gas research programs would be to reduce the rising dependence on foreign oil by utilizing domestic resources. Technology is the key to achieving such a goal. And technology can advance only with research. Given the state of energy geopolitics today, it follows that Federally supported oil and gas research is critical to helping sustain America's energy and economic security while safeguarding the environment.

Introduction

NETL/SCNGO mission

The National Energy Technology Laboratory implements natural gas and oil research and development programs under the aegis of the Department of Energy's Office of Fossil Energy.

This mission has taken on greater urgency as energy costs and U.S. oil and gas import levels continue to spiral upward. Yet the bulk of the Nation's discovered gas and oil resource remains untapped due to a range of environmental, supply, and reliability constraints.

NETL's mission focuses on developing science and technology to resolve these constraints. This is accomplished by investing in research with clear and tangible public benefits: a cleaner environment, more secure and stable energy supplies, and increased domestic natural gas and oil production.

This wide range of R&D includes:

- Drilling innovations that target otherwise uneconomic or inaccessible resources.
- Improved diagnostic and imaging technologies that enable explorationists to better visualize subsurface formations and reservoir/well behavior.
- More-efficient and environmentally responsible oil and gas production technologies.
- Work targeting production of unconventional domestic oil and gas resources.
- Advanced technology to improve natural gas storage capabilities and safer gas transmission and distribution systems.
- Government energy policy analysis to better characterize the impact of technology on the domestic gas and oil sector.

NETL is accomplishing this vital R&D mission in partnership with the private sector, academia, and industry associations to ensure that domestic petroleum resources continue to be a viable component of a robust and diverse energy portfolio for America. These partnerships are designed to leverage funds, ensure relevance, and encourage technology transfer of this R&D effort.

With offices in Morgantown, WV, Pittsburgh, PA, Tulsa, OK, Fairbanks, AK, and Albany, OR, NETL's oil and gas R&D program has four main areas: the Office of Natural Gas, Office of Petroleum, Petroleum Systems Analysis and Planning, and the Arctic Energy Office.

Office of Petroleum

NETL's Office of Petroleum is guided by a vision of U.S. technology and policy leadership centered on ensuring a reliable and affordable oil supply to drive the U.S. economy.

Dubbed "Operation Oil Freedom," this vision comprises five elements:

- Increasing domestic oil production, thus reducing U.S. reliance on oil imports.
- Securing the Nation's control of its oil supply,
- Creating and retaining domestic oil sector and related jobs.
- Ensuring that American companies remain world leaders in oil technologies.
- Upholding environmental values in the pursuit of these goals.

These efforts are more crucial than ever at a time when a global consensus is emerging that currently higher oil prices will be the order of the day for the foreseeable future. At the same time, concern grows over whether future global oil supply will be able to meet demand. Furthermore, the Nation's own levels of oil reserves and production continue to decline and its refining capacity continues to lag, while its demand for both crude oil and refined products continues to climb.

The Office of Petroleum vision supports NETL's goal of enhancing U.S. energy security by advancing technological solutions—backed by environmentally responsible science—for boosting domestic oil resource recovery.

The Office of Petroleum also works to support the NETL mandate to promote technology transfer, especially to America's small, independent oil producers. As with NETL's other programs, the office accomplishes its mission in partnership with industry and academia.

The Office of Petroleum splits its focus among Exploration & Production (E&P), Environmental Solutions, and Petroleum Fuels. There is some overlap with NETL's Arctic Energy Office, which incorporates projects funded through both the Office of Petroleum and the Office of Natural Gas.

Office of Petroleum E&P

The Department of Energy's oil exploration and production program has its roots in a government response to the oil embargo of 1973-74.

The program was launched with the intent of increasing domestic oil production in order to reduce U.S. reliance on oil imports.

As then, the government's role in E&P continues to be that of stimulating, facilitating, and coordinating research and development of upstream technologies whose risks surpass industry thresholds, then quickly transferring those technologies for possible commercial application. The goal is to leverage those technologies in a way that supports a revitalized domestic oil industry capable of exploiting more of the U.S. oil resource base that is currently deemed uneconomic.

That oil resource base is huge. Of the total remaining discovered oil resource estimated at 407 billion barrels of original-oil-in-place, about 218 billion barrels lying at depths shallower than 5,000 feet is thought to be recoverable with near-to-midterm advanced technologies. At a conservative 10 percent incremental recovery threshold, that yields a volume close to the current estimate of total remaining proven oil reserves in the United States.

Most of this targeted resource lies in mature producing areas of the United States. Even a relatively modest step-change in technology adopted to pursue these "stranded barrels," such as microhole technology, could revitalize declining oilfields across the Nation, return U.S. oil production to an upward growth path, and spur the creation of tens of thousands of jobs within and tied to the American oil and gas industry.

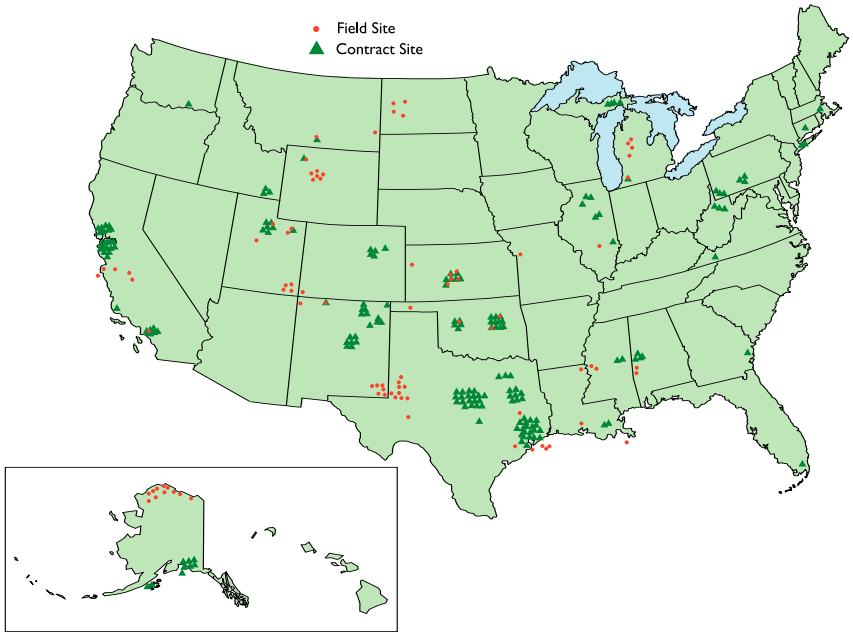
At the same time, the Office of Petroleum's E&P mission is underlain with a strong sense of environmental friendliness in the pursuit of this improved resource access. The E&P program's key environmental drivers are to 1) reduce the industry's environmental footprint and 2) accelerate the injection of carbon dioxide for enhanced oil recovery in support of sequestration-based climate change initiatives.

The program's efforts through public-private partnerships are projected to result in a cumulative increase of 1.4 billion barrels of economically recoverable oil reserves over the 2005-2015 planning horizon. It would maintain a balanced portfolio of projects that 1) span technology development stages from basic research to commercial demonstrations; 2) target specific end users, such as small, independent producers and service companies; and 3) apply to a range of resource targets, from mature fields to arctic areas.

The Office of Petroleum's E&P program has four major technology focus areas:

- Resource Finding and Recovery, which targets development of seismic and other imaging technologies, geologic modeling tools, and reservoir characterization and modeling methods.
- Access Technologies, which focuses on development of drilling, completion, production, and other tools to better enable economic access to a greater area of the oil reservoir.
- Oil Production, which consists of two main budget areas, Exploration & Production and Reservoir Life Extension/Management.
- Technology Transfer, which conveys project results to domestic stakeholders through Petroleum Technology Transfer Council workshops, DOE/NETL publications and websites, external publications and conferences, and educational outreach programs.

Collectively, these detailed project summaries represent just a portion of the scope of critical oil and gas research and technology advancement that NETL sponsors as the largest single proponent of petroleum industry research in America.



Active NETL Oil Exploration and Production Projects

This map depicts contractor locations and project sites related to the NETL Oil Exploration and Production program. There are about 150 active or recently completed NETL Oil Exploration and Production program projects (as of FY2005-2006) detailed in this book.